# Efficacy of Mechanical Insufflation-Exsufflation in Extubating Unweanable Subjects With Restrictive Pulmonary Disorders

In this issue of RESPIRATORY CARE, Bach et al[1] report the successful extubation of 97 of 98 subjects with profound respiratory muscle weakness using mechanical insufflation-exsufflation with the CoughAssist device, which promotes secretion removal and reverses atelectasis. To be considered for weaning from an endotracheal tube to full-time/continuous noninvasive ventilatory support, subjects had to fail several weaning criteria, including: inability to tolerate 4 h on a T-piece, significant airway secretions with poor cough capacity, vital capacity of $< 10$ mL, and signs of fatigue on low-level pressure support. Subjects had to be capable of correcting desaturation to an $S_{pO_2}$ of $> 95\%$ using mechanical insufflation-exsufflation. Additional criteria were refusal of a tracheostomy and agreement to attempt weaning to continuous noninvasive ventilatory support. Despite intubation for up to 158 d, successful extubation, defined as extubation for the remainder of hospitalization and subsequent follow-up, was achieved in a mean of 3.4 d (range of 2–8 d). This is a remarkable outcome for a population with an average vital capacity of 303 mL immediately before extubation (186 mL on admission) and considered unweanable by the referring ICU teams.

Extubation success was achieved by intensive airway clearance using mechanical insufflation-exsufflation via an endotracheal tube with pressures of 60–70 cm $H_2O$ up to every 60 min until $CO_2$ was normalized and an oxygen saturation of $\geq 95\%$ was achieved. Following extubation, ventilatory support was provided with noninvasive volume assist/control ventilation without PEEP via a mouthpiece (or nasal mask if preferred). Mechanical insufflation-exsufflation treatments were provided up to every 30 min using pressures of 35–60 cm $H_2O$ by both ICU clinicians and trained family members.

Although most patients in critical care units are able to wean from invasive mechanical ventilation with relative ease, a significant proportion (up to 30%) may experience difficult or prolonged weaning,[2] with some patients continuing to need some form of ventilatory support in the long term. These patients utilize 40% of ICU bed days and 50% of ICU costs.[3-6] Individuals with neuromuscular disease or ICU-acquired weakness make up a small but important number of patients experiencing difficult or prolonged weaning in ICUs and a larger proportion of those in other care locations, such as weaning units, respiratory intermediate care units, and long-term acute care hospitals in the United States, that admit medically stable patients after 21 d in the ICU. As such, they represent an important patient population in terms of ICU bed occupancy and utilization of health service resources and related costs. Understanding the principles behind the extubation success reported by Bach et al[1] is therefore critical for facilitating positive outcomes for these patients, including a return to living in the community.

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The predominant approach to determining weaning and extubation readiness in the ICU is through a spontaneous breathing trial. If these trials are unsuccessful, progressive reductions in pressure support or daily T-piece/tracheostomy collar trials are used.[7,8] A number of parameters have been established that may suggest a patient's readiness for weaning, including tidal volume, breathing frequency, minute volume, rapid shallow breathing index, and maximum inspiratory pressure; however, none have been shown to have sufficient sensitivity and specificity.[9] Ineffective cough, which can be addressed with lung volume recruitment and use of mechanical insufflation-exsufflation, has been shown to predict extubation failure.[10] Patients with neuromuscular disease or ICU-acquired weakness may repeatedly fail spontaneous breathing trials and, unless additional strategies are used, will require long-term tracheostomy ventilation and transfer to a long-term care facility, the consequences of which are increased risk of ventilator-associated complications, inability to return home, and decreased quality of life.

Many patients with muscle weakness and without primary lung disease, such as those with muscular dystrophy, spinal cord injury, and spinal muscular atrophy, are managed successfully in the community with various modali-

The authors have disclosed no conflicts of interest.

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DOI: 10.4187/respcare.04051

ties. These techniques include lung volume recruitment and use of mechanical insufflation-exsufflation to maintain airway clearance, along with noninvasive volume control ventilation via a mouthpiece during the day and via a mask interface at night. As such, tracheostomy is avoided. These patients, with little to no measurable pulmonary function, are representative of the population described by Bach et al[1] and traditionally considered unweanable by ICU clinicians.

Despite impressive results in terms of successful extubation in a relatively short time frame, the results of this study may not be easily generalizable to the average ICU. Subjects were referred to the study center from other ICUs for extubation by this specialized team experienced in the management of mechanical insufflation-exsufflation and noninvasive volume-control continuous mandatory ventilation with a mouthpiece. The ability to perform mechanical insufflation-exsufflation on a half-hourly basis and facilitate family member participation in the delivery of this intervention is likely beyond the capabilities of the average ICU. Lack of familiarity with these techniques in other centers also suggests that the same results may not be found in less experienced hands. Nevertheless, this study provides further evidence that mechanical insufflation-exsufflation may be useful in the ICU for certain patients experiencing difficult and prolonged weaning.

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